What is claimed is:

1. A method for humidifying a first fluid stream using a membrane exchange apparatus and a second fluid stream, wherein said first fluid stream comprises a first gas composition, and said second fluid stream comprises water vapor and a second gas composition that is different from said first gas composition, said method comprising:

(a) employing a water permeable membrane comprising a microporous polymer and a hydrophilic additive, said membrane being substantially permeable when dry to at least one component of at least one of said first and said second gas compositions;

(b) directing said first fluid stream across a major surface of said membrane,

(c) directing said second fluid stream across an opposing major surface of said membrane,

whereby said first fluid stream is humidified as it passes across said membrane surface.

2. The method of claim 1 wherein said membrane when wet is substantially impermeable to said at least one component.

3. The method of claim 1 wherein said membrane transfers up to about 1% of a fluid volume through said membrane.

4. The method of claim 1 wherein said membrane comprises a quantity of hydrophilic additive sufficient to render said membrane wettable to water.

5. The method of claim 1 wherein said second fluid stream further comprises liquid water.

6. The method of claim 5 wherein the dewpoint of said second fluid stream is greater than the temperature of said second fluid stream.

7. The method of claim 2 wherein said first gas composition is air and said second gas composition is oxygen-depleted air.

8. The method of claim 1 wherein said hydrophilic additive comprises at least one of silica and alumina.

9. The method of claim 1 wherein said hydrophilic additive comprises at least one of a fiber and a powder.

10. The method of claim 8 wherein said membrane comprises hydrophilic additive in an amount greater than about 25% by weight.

11. The method of claim 1 wherein said microporous polymer is high density polyethylene.

12. The method of claim 1 wherein said membrane porosity is greater than about 50%.

13. The method of claim 1 wherein said membrane average pore size is about 0.025 to 0.1 micrometers.

14. The method of claim 1 wherein said membrane Gurley air flow is about 500 to 4000 seconds per 100 cm^3 air.

15. A method for humidifying a reactant gas supply stream for a solid polymer fuel cell, said reactant gas supply stream being directed to a reactant gas inlet port of said fuel cell, said fuel cell having a reactant gas exhaust stream directed from a reactant gas exhaust port of said fuel cell, said method comprising:

(a) employing a membrane exchange humidifier comprising a supply stream chamber, an exhaust stream chamber, and a water permeable membrane separating said chambers, said membrane comprising a microporous polymer and a hydrophilic additive, said membrane when dry being substantially permeable to at least one component of at least one of said reactant gas supply and exhaust streams;

(b) directing said reactant gas supply stream through said supply stream chamber upstream of said fuel cell reactant gas inlet port; and

(c) directing said reactant gas exhaust stream from said reactant gas exhaust port through said exhaust stream chamber;

whereby water is transferred from said reactant gas exhaust stream to said reactant gas supply stream across said membrane.

16. The method of claim 15 wherein said membrane when wet is substantially impermeable to said at least one component.

17. The method of claim 15 wherein said membrane transfers up to about 1% of a reactant gas volume through said membrane.

18. The method of claim 15 wherein said reactant gas supply stream is an oxidant supply stream and said reactant gas exhaust stream is an oxidant exhaust stream.

19. The method of claim 15 wherein the flow rate of said reactant gas supply stream through said supply stream chamber is selected such that the residence to diffusion time ratio, R, for a hypothetical water molecule in said supply stream chamber is in the range from about 0.75 to about 3.

20. The method of claim 15 wherein the flow rate of said reactant gas exhaust stream through said exhaust stream chamber is selected such that the residence to diffusion time ratio, R, for a hypothetical water molecule in said exhaust stream chamber is in the range from about 0.75 to about 3.

21. The method for humidifying a reactant gas supply stream for a solid polymer fuel cell, said reactant gas supply stream being directed to a reactant gas inlet port of said fuel cell, said fuel cell having a reactant gas exhaust stream directed from a reactant gas exhaust port of said fuel cell, said method consisting essentially of:

(a) employing a membrane exchange humidifier comprising a supply stream chamber, an exhaust stream chamber, and a water permeable membrane separating said chambers, said water permeable membrane comprising a microporous polymer and a hydrophilic additive, said membrane when dry being substantially permeable to at least one component of at least one of said reactant gas supply and exhaust streams;

(b) directing said reactant gas supply stream through said supply stream chamber upstream of said fuel cell reactant gas inlet port; and

(c) directing said reactant gas exhaust

stream from said reactant gas exhaust port through said exhaust stream chamber;

whereby water is transferred from said reactant gas exhaust stream to said reactant gas supply stream across said membrane.

22. A solid polymer fuel cell system comprising a solid polymer fuel cell and an apparatus for humidifying a reactant gas supply stream, said fuel cell having a reactant gas inlet port and a reactant gas exhaust port, said humidifying apparatus comprising a membrane exchange humidifier comprising:

(a) a supply stream chamber having an inlet and an outlet, said supply stream chamber inlet having a reactant gas supply fluidly connected thereto, said supply stream chamber outlet being fluidly connected to said fuel cell reactant gas inlet port;

(b) an exhaust stream chamber having an inlet and an outlet, said exhaust stream chamber inlet fluidly connected to said fuel cell reactant gas exhaust port; and

(c) a water permeable membrane separating said supply stream chamber and said exhaust stream chamber, whereby water is capable of being transferred across said water permeable membrane from a reactant gas exhaust stream to said reactant gas

supply stream, said membrane comprising a microporous polymer and a hydrophilic additive, said membrane when dry being substantially permeable to at least one component of at least one of said reactant gas supply and exhaust streams.

23. The solid polymer fuel cell system of claim 22 wherein said membrane when wet is substantially impermeable to said at least one component.

24. The solid polymer fuel cell system of claim 22 wherein said membrane is permeable to up to about 1% of a reactant gas volume during steady state fuel cell operation.

25. The solid polymer fuel cell system of claim 22 wherein said reactant gas supply stream is an oxidant supply stream and said reactant gas exhaust stream is an oxidant exhaust stream.

26. The solid polymer fuel cell system of claim 22 wherein said membrane exchange humidifier has a configuration selected from the group consisting of plate-and-frame, spiral wound and tube bundle.

27. The solid polymer fuel cell system of claim 26 wherein said membrane exchange humidifier has a plate-and-frame stack configuration.

28. The solid polymer fuel cell system of claim 27 wherein said membrane exchange humidifier configuration comprises a stack of at least one membrane and frame unit, said unit comprising said membrane interposed between an upper frame and a lower frame, said upper frame comprising two upper ports and said lower frame comprising two lower ports, said unit further comprising seals disposed between said membrane and portions of said frame surrounding each of said upper and lower ports, at least one of said seals consisting essentially of a bond formed between said membrane and said upper and lower frames, said membrane comprising four openings, two of said openings aligned with said upper frame ports and the other two of said openings aligned with said lower frame ports, whereby fluid communication is provided between said lower frame ports and said upper frame interior and between said upper frame ports and said lower frame interior.

29. The solid polymer fuel cell system of claim 28 wherein said upper ports are located at opposite ends of the upper frame periphery and said lower ports are located at opposite ends of the lower frame periphery.

30. The solid polymer fuel cell system of claim 28 wherein said seals consist essentially of bonds formed between said membrane and said upper

and lower frames.

31. The solid polymer fuel cell system of claim 28 wherein said two lower frame ports substantially align with said two upper frame ports.

32. The solid polymer fuel cell system of claim 28 wherein said unit is substantially rectangular.

33. The solid polymer fuel cell system of claim 28 wherein said lower frame is of substantially the same construction as said upper frame and said upper frame is rotated with respect to said lower frame in said unit.

34. The solid polymer fuel cell system of claim 22 wherein said membrane comprises formed ribs.

35. The solid polymer fuel cell system of claim 34 wherein said water permeable membrane is spirally wound and said formed ribs are configured so as to form said supply stream and exhaust stream chambers in said spirally wound membrane.

36. The solid polymer fuel cell system of claim 34 wherein said formed ribs exhibit a tongue-in-groove geometry.

37. The solid polymer fuel cell system of claim 22 wherein said membrane comprises a bundle of substantially rectangular tubes.

38. A solid polymer fuel cell system comprising a solid polymer fuel cell and an apparatus for humidifying a reactant gas supply stream, said fuel cell having a reactant gas inlet port and a reactant gas exhaust port, said humidifying apparatus comprising:

(a) a membrane exchange humidifier comprising a supply stream chamber having an inlet and an outlet, said supply stream chamber inlet having a reactant gas supply fluidly connected thereto, said supply stream chamber outlet being fluidly connected to said fuel cell reactant gas inlet port, said membrane exchange humidifier comprising a stack of at least one membrane and frame unit, said unit comprising said membrane interposed between an upper frame and a lower frame, said upper frame comprising two upper ports, said lower frame comprising two lower ports, said membrane comprising four openings, two of said openings being aligned with said upper frame ports and the other two of said openings being aligned with said lower frame ports, said unit comprising seals disposed between said membrane and

the frame portions surrounding each of said upper and lower ports, at least one of said seals consists essentially of a bond formed between said membrane and said upper and lower frames, whereby fluid communication is provided between said lower frame ports and said upper frame interior and between said upper frame ports and said lower frame interior;

(b) an exhaust stream chamber having an inlet and an outlet, said exhaust stream chamber inlet fluidly connected to said fuel cell reactant gas exhaust port; and

(c) a water permeable membrane separating said supply stream chamber and said exhaust stream chamber;

whereby water is capable of being transferred across said water permeable membrane from a reactant gas exhaust stream to said reactant gas supply stream.